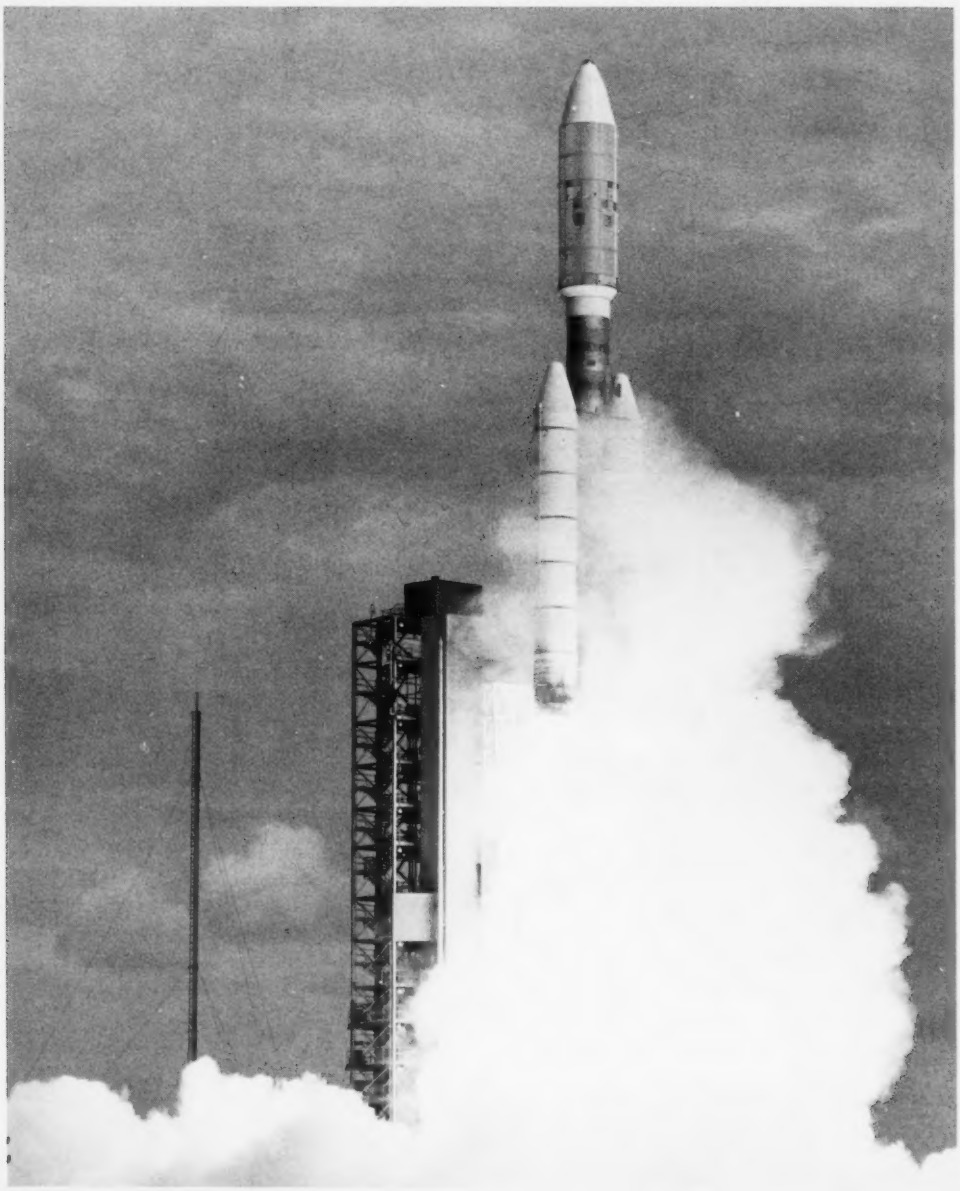
NASA Activities

National
Aeronautics and
Space
Administration

Vol. 8, No. 9
September 1977



Cover

Voyage to Infinity—Lifted off by a Titan/Centaur-7 from Cape Canaveral, the first of two Voyager missions into the far reaches of space began on Aug. 20, 1977. A sister spacecraft will follow as the two 825-kilogram satellites wing their way to Jupiter, Saturn, moons of both planets, and perhaps also to Uranus. Soon after the launch—which at first appeared perfect—JPL project managers detected problems related to the deployment of a boom bearing instruments vital to planned observations of the distant planets. Voyager scientists later were able to conduct tests which revealed that the instrument-carrying boom was deployed probably 95 percent of its full length of 1.83 meters. Launch of the second Voyager, originally planned for Sept. 1, was delayed to permit project managers to ascertain whether the boom was solidly locked in place on the first Voyager.

NASA Activities is published monthly by the National Aeronautics and Space Administration for the information of the Agency's employees.

Contributions and recommendations are solicited from headquarters and field centers, and should be addressed to the Office of Public Affairs, Code FP, Washington, D.C. 20546.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription rate: $11.55 domestic; $14.45 foreign. Price per single copy: $1.00 domestic, $1.25 foreign. Back issues not available.

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Letter from Washington

Dear Colleagues:

One of the youngest government agencies now coordinates with this nation's oldest established sea-going service in the humanitarian operation called "Search and Rescue." Ships and planes of the Coast Guard will work with NASA's space satellites to detect and locate emergency beacons now carried by general aviation and some maritime vessels.

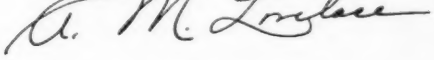
The program will make a significant contribution to search-and-rescue techniques by reducing costs while increasing the probability of saving lives. Currently in the United States, there are some 150,000 private aircraft and many thousands of boats and ships carrying radio beacons that automatically transmit distress signals. Until now, the lack of an adequate method to monitor and find the source of such signals has made the system only marginally effective. The new system, beginning in FY 1978, assures an almost continuous scan of distress frequencies and should permit fast and precise location of crafts in distress. Search-and-rescue packages are going to be carried aboard NOAA and Air Force meteorological satellites consisting of four spacecraft positioned equidistant around the globe. Their altitude will permit constant coverage of the entire Earth. The potential of worldwide utility is seen in the interest expressed by the Government of Canada.

When operational, distress alerts will be relayed by satellite to Earth terminals located at existing rescue coordination centers where the position of a beacon will be determined by computer. We expect the first of the packages to be in orbit soon, with others to follow. With placement of each additional component, the time between occurrence and rescue will be cut sharply.

In addition to Canada, we are working with the National Oceanic and Atmospheric Administration as well as the Coast Guard and the U.S. Air Force.

Despite the seeming ease of movement in space, travel on Earth and in its atmosphere remains fallible. Tankers crack up, planes go down. Using the unique perspective provided from orbit will allow search areas to be identified faster and the prospect of successful rescue to be materially improved. Because we operate in space, the world will be a safer place.

Sincerely,



Alan M. Lovelace

SATELLITE SEARCH AND RESCUE
• USES EXISTING SATELLITES, GROUND STATIONS, AND BEACONS
• COVERS U. S., CANADA, ALASKA, AND 200-MILE LIMIT
• WILL LOCATE ALL DISTRESS BEACONS WITHIN 2 HOURS
• CANADA WILL HELP FUND A JOINT SYSTEM

"Piggyback" Aircraft Concepts Have Long History

Stacked atop its carrier Boeing 747 aircraft, the Space Shuttle orbiter *Enterprise* looks like a back-breaking load for the jumbo jet. One of the 747 pilots characterized the stack as "the world's largest biplane." But the *Enterprise*-Boeing 747 combination is by no means the first such piggyback or composite rig in aviation history.

Midway through World War I the British experimented with a Bristol Scout perched atop a Felixstowe three-engine flying boat. The concept was to get the Scout airborne and release it at the correct altitude for intercepting and attacking German Zeppelin bombers over England.

The stack flew once May 17, 1916. The Bristol Scout was flown by Flight Lieut. M. J. Day and the flying boat was piloted by John Cyril Porte. Release was successful and both aircraft landed, but the experiment was not repeated or pursued.

The composite idea resurfaced two decades later when the British developed the Short-Mayo composite as a means of getting a heavily-loaded seaplane airborne. The "mother" flying boat, called *Maia,* carried a smaller seaplane—*Mercury*—on a pylon and made the first separation flight Feb. 6, 1938. In July of that year, the pair flew from Foynes, Ireland nonstop to Montreal with a load of mail and newspapers.

The two four-engine aircraft made numerous composite flights with separations, including a record-setting flight from Dundee, Scotland, to the Orange River in South Africa—a 9,650-kilometer seaplane distance record that still stands. *Maia* and *Mercury* were operating between Southhampton and Alexandria, Egypt, when World War II broke out. *Mercury* was scrapped in 1941 after serving with a Dutch seaplane squadron attached to the Royal Air Force. *Maia* was destroyed by a Luftwaffe bomb May 11, 1941, while moored in an English harbor.

Composite aircraft configurations were used as weapons by the Luftwaffe during the Allied invasion of France in mid-1944. The Luftwaffe program was first dubbed the *Beethoven-Gerat* (Beethoven-device) for some strange reason, and later changed to *Mistel,* or mistletoe.

A *Mistel* composite usually consisted of an unmanned Junkers 88 bomber plane loaded with about 3,400 kilograms of explosives and a Messerschmitt 109 or Focke-Wulf 190 fighter craft mounted on a pylon. The fighter pilot would fly the combination toward a target, separate and, hope to fly away before the Ju 88 impacted. About 150 *Mistels* were built, but 125 Ju 88 lower segments were captured intact when Nordhausen fell to the Allies. The Germans also experimented with launching DFS 230 assault gliders from Messerschmitt Bf 109 fighters used as ferry planes.

The Soviet Union also dabbled in piggyback airplanes in the 1930s with the *Link* composite in which two Sukhoi I-4s were rolled up ramps onto each wing of a Tupolev TB-1 bomber. The fighters helped out on takeoff, then shut off their engines until the target was reached.

The piggyback concept was tried by the French in the years following the end of World War II as a means of getting the Leduc 010 up to the speed where its ram-jet engine would function. Two prototype Leduc 010s were built, and the first free flight was Oct. 21, 1947. Both prototypes were destroyed in the test program, and a follow-on Leduc 016 aircraft, fitted with two conventional jet engines, made 83 test flights. The program was abandoned in the 1950s because of lack of official support.

Closer to home, the U.S. Air Force and NACA—the predecessor of NASA—experimented with parasite aircraft carried beneath or in the bomb bay of the mother aircraft—perhaps properly called "piggybelly" composites. Some of these were research aircraft, such as the Bell X-1 and X-2, Douglas D-558-2, and North American X-15. Others were experimental fighters such as the McDonnell XF-85 Goblin—which surely qualified as one of the ugliest airplanes ever built. It could be launched as well as recovered from a trapeze rig hanging out of the Boeing B-29 Superfortress bomb bay. Only three successful recoveries were made in the test program, which began in 1948.

In the 1950s, the Air Force fitted a squadron of Convair B-36 bombers with skyhooks for launching and retrieving Republic RF-84F fighters. But as the emphasis shifted toward extending the range of fighter planes, by the end of the decade the program was phased out.

After a rather dismal history of failure and lack of support for the composite idea, the Shuttle and orbiter came to be regarded as a practical approach toward solving problems in flight test and logistics. Early planning for moving Shuttle orbiters from the factory on the West Coast to the launch site at Kennedy Space Center involved strap-on jet engine packs for flying the orbiters like airplanes in several hops over the 4,825 km. But the problems of trying to make a part-time airplane out of a full-time spacecraft—loading enough jet fuel for the cross-country ferry

flight, the hazards of numerous landings enroute—forced a new approach.

Spacecraft design engineer John Kiker at NASA's Johnson Space Center resurrected the long-forgotten piggyback concept as a way to ferry orbiters from coast to coast and as a means of launching an orbiter for atmospheric tests of the landing system and handling characteristics for those brief minutes when an orbiter becomes an airplane.

Many carrier aircraft—double Lockheed C-5As, double 747s, specially designed and built aircraft—were considered but discarded as too costly or impractical before the orbiter-747 piggyback was selected.

Once the approach and landing tests have been completed at NASA's Dryden Flight Research Center NASA 905 (as the ferry craft is designated) still will have plenty of work to do. The jumbo jet will carry *Enterprise* to NASA's Marshall Space Flight Center for vibration tests next year and will carry a second orbiter from the Dryden center to the Kennedy Space Center for the orbiter flight tests in 1979. The second orbiter will land on the dry lake bed at Dryden Center after returning from space in the orbital flight tests and then will be ferried back to Kennedy for refurbishment for the next flight.

Later orbiters coming off the line at Rockwell International Space Division's plant at Palmdale, Calif., will be towed 35 miles overland to the Dryden center to be hoisted atop the 747 for ferrying to Florida.

An idea that was first tried 61 years ago with the wood-wire-and-fabric Bristol Scout for chasing Zeppelins is finally paying off.

Maia-Mercury Combination—The Short-Mayo Composite seemed an efficient means of getting a heavily-loaded seaplane airborne. The "mother" flying boat, called *Maia*, carried a smaller airplane, Mercury, on a pylon and made the first separation flight Feb. 6, 1938. In July of that year, the pair flew from Foynes, Ireland, nonstop to Montreal with a load of mail and newspapers. The two four-engine aircraft made numerous composite flights with separations.

The German "Mistel"—Composite aircraft configurations were used as weapons by the Luftwaffe during the Allied invasion of France in mid-1944. The Germans also experimented with launching DFS 230 assault gliders from Messerschmitt fighters used as ferry planes.

Long-Silent Satellite Comes to Life

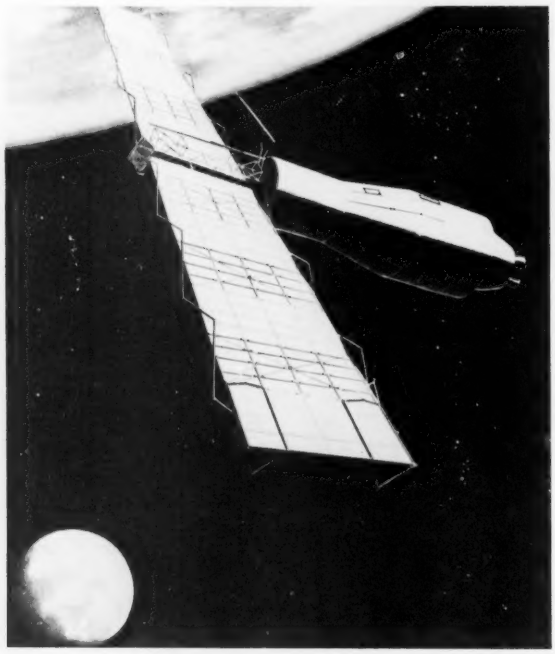
Last June 27, the Marshall center was notified by network operations at NASA's Goddard Space Flight Center that a beacon transmitter on Pegasus I was "on" and intermittently interfering with data transmission from another satellite.

After launch 12 years ago on a Saturn I vehicle, Pegasus deployed its 28-meter wings in Earth orbit and exposed 212 square m of instrumented surface to gather meteoroid data and transmit them to receiving stations on Earth.

Marshall center officials authorized Goddard's operations unit to take control of the transmissions and, on June 28, 1977, a command was sent from Orroral, Australia, that turned off the satellite's AM beacon. It was then discovered that the FM beacon also was transmitting. Both signals were strong.

The transmitters operated only when the vehicle was in sunlight. The AM beacon was modulated. Signal strength recordings were made of both transmitters before the "off" command was given.

Officials have not yet determined why the transmitters unexpectedly turned on. The incident is being investigated from available drawings.



Strange Noises from Outer Space—Space listeners were startled recently when signals were received from the satellite Pegasus 1, launched Feb. 16, 1975 for the Marshall Space Flight Center. Its system was closed down almost 10 years ago and not expected ever to be revitalized.

Taylor Joins MSFC Public Affairs

John B. Taylor recently was named head of the public information branch of the Marshall center's public affairs office, replacing Guy Jackson, who has succeeded retired Richard Pratt as chief of the office's public services and education branch.

Taylor, 33, a journalism graduate of Utah State University and a former Air Force officer, has had extensive experience in the information field. His most recent assignment was as executive editor of *Airman* magazine.

He also has served as director of information at MacDill Air Force Base, Fla. He represented the Air Force in a public information capacity in Apollo mission recovery activities, and has written extensively of NASA and Defense Department space work.

Flood-Stricken Johnstown Area Aided by Satellite

What began as a dry run wound up with the world's most powerful communications satellite being used in July to transmit disaster-related information from flood-inundated Johnstown, Pa., to the American Red Cross headquarters in Washington, D.C.

The Johnstown events began when the Communications Technology Satellite, a cooperative NASA and Canadian spacecraft launched in January 1976, was being tested by the Red Cross and the Comsat Corp. in a simulated disaster situation in Texas. The tests were part of a research program Comsat is working on with the CTS in an experiment that sought to demonstrate and evaluate emergency communications by satellite in the presence of natural disasters.

Results of the Texas tests so impressed Red Cross officials that they requested that the transmission equipment be brought north for use in Johnstown, where communications had been seriously impaired by floods. The CTS-Comsat experiment then was transported from Houston to Johnstown and the portable unit was set up there, near the University of Pittsburgh.

The equipment included a 1.2-meter portable antenna which transmitted and received signals from the CTS which is in synchronous orbit, stationed over the equator at an altitude of about 36,000 kilometers at 116 degrees W. longitude, just west of South America.

All ensuing communications were disaster-related, including requests for medical and doctor services, supplies and administrative services and situation maps which also were transmitted. From Johnstown,

messages went through CTS to Comsat in Clarksburg, Md., where a 4.6-m antenna was used. Comsat at Clarksburg was connected with Red Cross headquarters in Washington, D.C., by land line. A tie-in with the telephone company also permitted Johnstown residents to use the CTS link to communicate with relatives around the country over two circuits which could be preempted whenever the Red Cross needed to use the lines.

The disaster-generated emergency resulted in preemption of Canadian and U.S. experiments that were scheduled for July 25 and 26.

The goal of the satellite is to probe the effects—social, cultural and economic—of its own new technology and attempt to show planners of future systems new ways of using modern communications tools. Experiments include tele-education, telemedicine, community interaction, data communications and broadcasting.

Landsat Observes Fifth Birthday

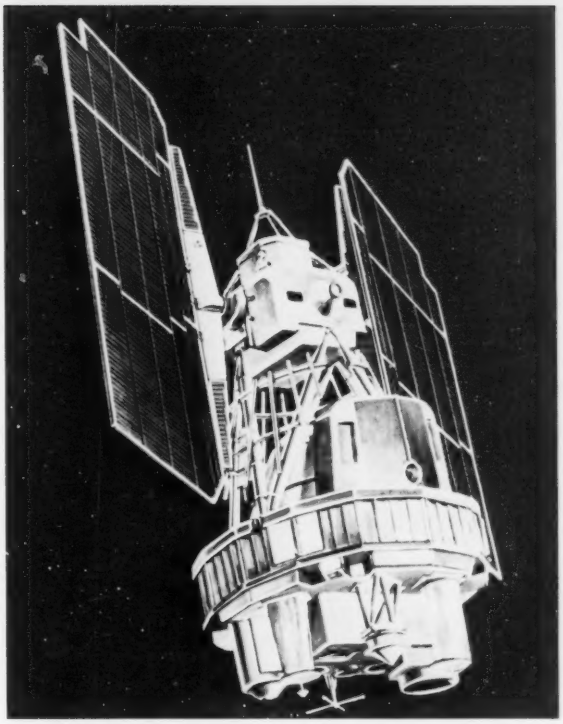
The first satellite ever launched to focus specifically on the Earth and its natural resources, completed its fifth year in orbit last week. Launched July 23, 1972—at that time estimated as having a life expectancy of one year—Landsat 1 carries devices that record and transmit to Earth the unique signatures radiated by land, water, minerals, vegetation and man-made structures.

Landsat 1 was joined by a second such satellite, Landsat 2, Jan. 22, 1975. Weighing some 816 kilograms and circling 925 kilometers above the Earth in polar orbit, each satellite photographs three strips 185 km wide covering North America, and 11 similar strips covering the rest of the world.

With each satellite 180 degrees apart, coverage of a given spot on the Earth is repeated every nine days. It is this repetitive coverage that provides Landsat with the ability for monitoring time-dependent changes in surface features. In early 1978, the system will be joined by a third satellite, Landsat 3. Landsats are built by the Space Division of General Electric Co., Valley Forge, Pa.

Few satellites have stirred more excitement than Landsat. The late space pioneer, Dr. Wernher von Braun, predicted that through this program alone, the nation could realize "a return exceeding its total space program investment."

Using the signatures and other data collected by the satellite, scientists have achieved some dramatic applications. Landsat imagery has provided raw data that helped to identify the polluters of air and water.



Earth Resources Satellite—An artist's concept of Landsat-2, the second earth resources satellite, which was placed in orbit Jan. 22, 1975. Its data are used for investigations of geology, hydrology, agriculture, land-use planning, and marine and water resources.

It has led geologists on oil and mineral hunts in Alaska, Oklahoma, the Rocky Mountains and the jungles of Brazil. Marine researchers have been able to detect potential fishing grounds. Changes in ecology brought on by forest fires, earthquakes and strip mining have been plotted. Urban development is guided by determining in advance how projected growth patterns will affect transportation needs, public service facilities and the environment.

Landsat's potential for agriculture is staggering. Farmland of an entire region can be sorted crop by crop in a matter of hours in combination with high-speed computers. The end result is a computer-printed terrain map showing the precise location and area of each crop with an accuracy of more than 90 percent. Investigators using Landsat images of California's Imperial Valley, for instance, completed inventories of more than 25 separate crops in 8,865 fields in 40 man hours. The total area covered was 185,150 hectares. Among the crops readily identified were corn, popcorn, soybeans, sorghum, oats, grasses (rye,

Bermuda, Alicia and Sudan), lettuce, mustard, tomatoes, carrots, onions and alfalfa. The scientists distinguished between wet-planted fields, plowed lands, harvested fields and bare soil in areas as small as 4.5 hectares. (The remote sensing devices on another Landsat scheduled for launch in the early 1980s will locate and identify these characteristics on a one-acre plot!)

This experiment demonstrated the potential of a satellite system to conduct extensive and repeated crop surveys which could increase accuracy and timeliness of forecasting harvest volume and contribute to decisions on new plantings to meet demands.

One such system using Landsat satellites is the Large Area Crop Inventory Experiment (LACIE), a three-year project involving NASA, the U.S. Department of Agriculture and the National Oceanic and Atmospheric Administration.

Designed to improve the accuracy of global crop forecasts, in its initial stages LACIE is aimed at forecasting wheat crops. It can, however, be expanded at a later date to include other major grains such as rice and corn. The first full crop year of LACIE has been completed as planned, and with the final successful completion of this major experiment, the United States will have demonstrated the technology required for an operational global crop forecasting system of paramount international political and economic significance.

To date, the oil and mining industries are the largest purchasers of Landsat data, which are made available through the U.S. Department of the Interior's EROS Data Center at Sioux Falls, S.D. Although the Landsat data use techniques are still experimental, there have been some notable successes locating new mineral deposits with the help of these images and tapes.

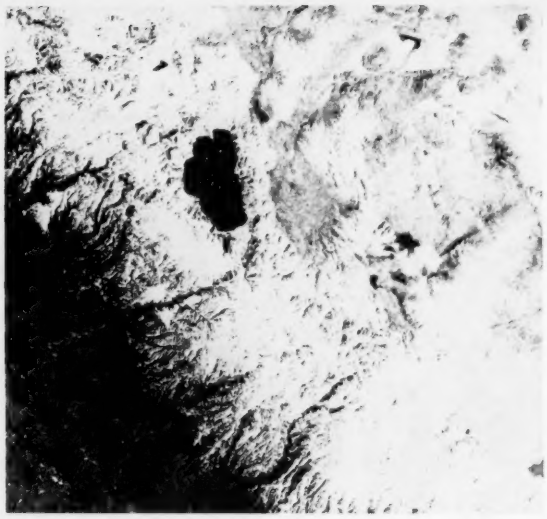
Landsat images completely free of clouds are now available for every part of the United States. A large-scale mosaic covering several western states has revealed some previously unrecognized details of an east-west fault associated with the Colorado mineral belt. Known mineral locations corresponding with those deduced from Landsat data thus have indicated the possibility of new and untapped lineaments revealing similar areas to be explored.

Accurate predictions of snowmelt are important in planning the best use of water for power generation, irrigation, flood control planning and estimating future water supplies for major cities. Up to now, such predictions—useful in deciding whether to hold or release water in reservoirs—have been based on less accurate observations made by individuals on foot or traveling in land vehicles, who penetrated remote wilderness areas, or by aircraft. NASA is working with other Federal agencies and several states in analyzing the data gathered by Landsat and weather satellites for predicting the amount of water to be expected from melting snow in mountain areas.

Snow Scarce on Sierra Nevada—Clear evidence of the West's continuing drought is shown in this satellite scene of the snow bare Sierra Nevada mountains. Covering 13,225 square miles, the image was recorded by the Landsat satellite Feb. 14, 1977, and radioed to NASA's Goddard Space Flight Center. Measurements made from this image reveal that the snowline is 2,000 feet higher in 1977 than in a comparable 1975 image, a near normal snowfall year. Information from snow survey teams and in-place ground sensors confirms that the available snow in the Sierras not only covers less area but is thinner. Lake Tahoe can be seen in the photograph center.

Landsat data also are being used in a cooperative effort to assess the marine environment in a 3.87-billion square-meter area of the Gulf of Mexico.

In combination with ground information gathered by a commercial fishing fleet of some 70 vessels, three oceanographic research ships, a low-flying "spotter" group of nearly 40 airplanes, four marine oil drilling rigs and a weather satellite, Landsat images have been used successfully to locate and harvest living marine resources in the Gulf. But even with all these applications it is obvious that the potential of Landsat has barely begun to be tapped.



Snow Laden Sierra Nevada—This satellite photograph of the Sierra Nevada mountains, covering a 13,225 square mile area, depicts a near normal snowpack Feb. 23, 1975. Measurements reveal that the snowline is 2,000 feet lower than the snowline in a comparable 1977 Landsat image. Lake Tahoe can be seen in the photograph center.

Sloan Fellowship to Langley Employee

Dr. Frank Allario, of NASA's Langley Research Center recently was selected by Stanford University as a Sloan Fellow for the 1977-78 academic year.

Allario was one of two employees nominated by NASA's Office of Professional Development for the Stanford-Albert P. Sloan Fellowship Program. The other was John P. McCarty, of the Marshall Space Flight Center.

Conducted by the Stanford Graduate School of Business, the program is designed for young middle-management executives with superior records of achievement. The program offers a master of science degree in management for satisfactory completion of the nine-month course. Sloan participants are sponsored and supported financially by their employing organizations.

Since January 1977, Allario has served as group leader of the laser heterodyne spectrometer experiment for the Spacelab. He performs laboratory research on tunable semiconductor lasers and their application to atmospheric pollution monitoring. He was head of the laser physics and applications section from November 1969 until appointment to his present position.

Allario graduated *cum laude* from Manhattan College in 1962, earning his bachelor of science degree in physics. In 1965, he earned his master of science and in 1967, his Ph.D. in physics from the Polytechnic Institute of New York. He is the author or co-author of some 30 technical papers or conference talks.

Boeing Selected to Build World's Largest Windmill

The largest windmill in history will be built during the next two years in a test program conducted by the Energy Research and Development Administration and managed by NASA.

The two agencies have selected the Boeing Engineering and Construction Co., a division of the Boeing Co. of Seattle, Wash., to design and build the new system. NASA and ERDA are negotiating a contract with Boeing for about $10 million to design, build, assemble, install and test a nominal 2.5 megawatt (2,500 kilowatt) electrical generating system, with blades spanning 91 meters in diameter.

The large wind turbine will be designed for sites with a mean speed of 23 kilometers per hour. Sites with such modest winds are relatively common throughout the United States. The wind turbine is scheduled to be built in late 1979 at a site to be selected by ERDA. The project will be directed for ERDA by NASA's Lewis Research Center.

Although experimental in nature, the system will be located at a utility company site and will supply electricity to the local electrical system for use by the general public. The purpose of this system is to investigate the economics and operating characteristics of large wind turbines when coupled with conventional power plants. The project will place special emphasis on developing a wind turbine capable (when produced in quantities of up to 100 units) of providing electricity at a cost approaching that of conventional power plants.

The experimental wind turbine (the name for modern electrical generating windmills) is part of ERDA's program to develop wind energy systems and test their practicality as a potential source of energy. The Lewis center, which has long displayed expertise in aerodynamics and structures, directs this element of ERDA's wind energy program.

Research to date has indicated that the cost of energy from the wind turbine should decrease as the size of the machine increases.

The largest operating wind turbine now in operation is the 100-kw, 39-m diameter system built for ERDA

by the Lewis center at its Plum Brook test area near Sandusky, Ohio. This test machine is being used to identify and solve technical problems associated with large wind turbines and to test advanced components for future wind turbines.

Three more powerful versions of this 39-m diameter system are being built by Lewis and the Westinghouse Electric Corp. The three machines will be installed at utility sites recently selected by ERDA at Clayton, N.M.; Block Island, R.I.; and Culebra, Puerto Rico. These sites were selected from among 17 candidate sites proposed by utility companies across the nation.

In addition, two 2,000-kw, 61-m diameter machines presently are being developed for ERDA by the General Electric Co. in Valley Forge, Pa. These wind turbines are designed for utility sites with a mean wind speed of 29 km/hr. The two machines will be installed in late 1978 and early 1979 at utility sites to be selected by ERDA from the remaining 14 candidate sites proposed by the utility industry.

ERDA is also investigating and developing small (up to 10 kw) windmills that could be used by individual rural homes or farms, and for carrying out research and development on advanced unconventional windmills.

Two Chosen as Thompson Fellows at Langley

Two members of the Langley Research Center are the initial recipients of Floyd L. Thompson Fellowships. They are Dr. Martin M. Mikulas, Jr., of the structures and dynamics division, and Dr. Calvin T. Swift of the flight electronics division. Mikulas will spend an academic year at the California Institute of Technology in Pasadena, doing research in the area of large space structures; Swift will be involved in microwave measurements research at the National Oceanic and Atmospheric Administration in Boulder, Colo.

The Floyd L. Thompson Fellowship Program was established to encourage the development of innovative research programs by staff members at the Langley center. Through this highly competitive program, individuals may spend up to one year in research at an educational or research institution of their choice. This unique experience should enhance individual research capability and provide a means for infusing the Langley center with new ideas from other centers of excellence in specific research fields.

The program, inaugurated in 1977, is in memory of Dr. Floyd L. Thompson, 1898-1976, who was Langley's director from 1960 to 1968. This aviation and space pioneer joined the Langley staff in 1926, and after retirement in 1968 remained as a consultant to the NASA administrator until January 1973. It is anticipated that two fellowships will be awarded each year.

Winning Fellows—Recipients of Floyd L. Thompson Fellowships Dr. Calvin T. Swift (left) and Dr. Martin M. Mikulas (second from left) discuss the new program with Langley director Hearth (right) and associate director Dunberg (second from right).

Administrator's Colloquium—Officiating at the colloquium for the first time since he became NASA's Administrator, Dr. Robert A. Frosch introduced Dr. Alvin M. Weinberg, director of the Institute of Energy Analysis to a headquarters audience of 150 at the third presentation of the 1977 "Profiles of the Future" colloquium series. Donning his "futurology hat," Weinberg addressed the question, "Can the Sun Replace Uranium?" Examining two scenarios on the future energy picture, one based on total dependence on the Sun and the other on uranium, Weinberg concluded that total dependence on any one source of energy is neither practical or wise. Weinberg has served as director of the Federal Energy Administration's Office of Energy Research and Development. He received the Atoms for Peace Award in 1960 for his development of nuclear reactors. Tapes in reel and cassette of 15 previous colloquium talks are available in the NASA headquarters library.

New Army Manager for Research Aircraft

Lt. Col. James H. Brown was appointed manager of the tilt rotor research aircraft project office in July. Brown, who previously was deputy manager of the project for almost two years, succeeded David D. Few of NASA's Ames Research Center, who was promoted to the position of assistant division chief, V/STOL technology division.

The XV-15 Tilt Rotor Research Aircraft is a joint Army-NASA project being built by Bell Helicopter Textron Corporation. It is a 13-meter long, 9-m wing span aircraft incorporating wingtip mounted engines, transmissions and 7¾-m prop rotors which tilt from a helicopter position for hover, vertical takeoffs and landings, to a horizontal position for forward flight.

In the airplane mode, the aircraft is capable of forward speeds in excess of 490-km/h. It is expected that the tilt rotor will operate with less noise than conventional helicopters or turboprop aircraft of comparable size.

Two aircraft will be built and tested under the contract. The first made its initial hover flight May 3 at Bell's Arlington, Texas, flight research center.

U.S.-Soviet Union Launch Rockets off Virginia Coast

NASA and the Soviet Hydromet Service conducted a two-week long rocketsonde (sounding rocket) intercomparison test near Wallops Island, Va., in mid-August. NASA launched its rockets from the Wallops Flight Center and the Soviet Hydromet Service launched its rockets from the *Akademik Korolev,* a hydrometeorological research ship located in international waters off the U.S. east coast.

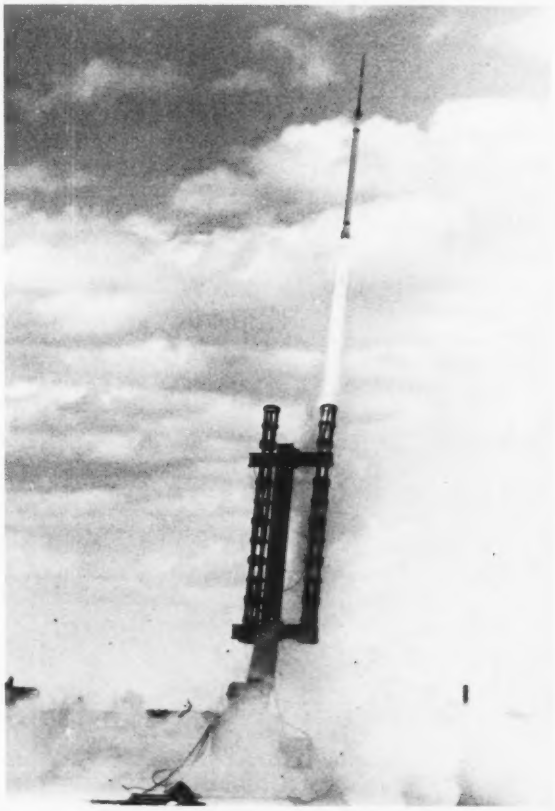
The objective of the intercomparision is to establish a basis for relating U.S. and Soviet measurements of upper air temperature and winds taken by meteorological instruments in their respective rocketsonde systems and to suggest possible corrections for any discrepancies found.

The 1971 NASA-Soviet Academy of Sciences agreement on space sciences and applications called for an exchange of meteorological rocket data from several launch sites along two meridian lines, one in the Eastern Hemisphere (about 70 degrees West). The Eastern Hemisphere network is coordinated by the U.S.S.R. Hydrometeorological Service (on behalf of the Soviet Academy) and the Eastern Hemisphere network is coordinated by NASA.

Both sides began performing hemispheric analyses on the basis of rocketsonde data exchanged in January 1972. Their analyses revealed that the measured temperature field in the Eastern Hemisphere was consistently colder than that of the Western Hemisphere. As a result of the discrepancy, both countries began evaluating their rocketsonde systems for possible sources of error.

In 1973, direct comparisons of the U.S., U.S.S.R., French and British rocketsondes were conducted at Kourou in French Guiana. These comparisons revealed some discrepancies in measurements of temperature and wind data.

Since the 1973 comparisons, improvements in meteorological rocket systems and data analysis techniques make it necessary to repeat comparisons of U.S. and U.S.S.R. systems.



Datasonde Rocket Launch—Liftoff of a super Loki Datasonde meteorological rocket from Wallops Island, Va. The operation was part of a U.S.-Soviet Union cooperative research program conducted from shore and at sea.

Space Shuttle Solid Rocket Motor Fired

The first firing of the largest solid rocket motor ever developed for space flight was conducted successfully July 18 near Brigham City, Utah. The motor for the Space Shuttle solid rocket booster (SRB) was tested by Thiokol Corporation's Wasatch Division, prime contractor to NASA's Marshall Space Flight Center.

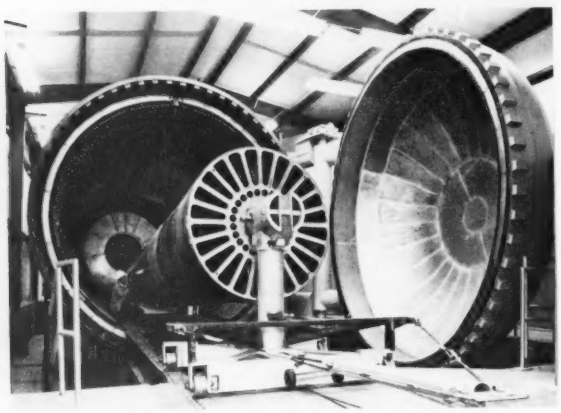
The solid rocket motor (SRM) has about 50 percent more propellant than the next largest motor ever fired at the site. Earlier firings were conducted to gather data on the feasibility and possibility of developing the large motor.

The largest solid propellant rocket currently in regular use is the Titan III. It has about 192,780 kilograms of propellant, or about one-third as much as the SRM.

The SRM, weighing 568,097.3 kg fueled, fired for 123 seconds, producing 12,232,550 Newtons of thrust. Propellant accounts for 502,454 kg of the SRM's total weight.

Thiokol's SRM is the propulsive part of the reusable SRB being developed for the Space Shuttle. The SRB is 3.7 meters in diameter and 45.5 m long.

The SRM uses a composite propellant consisting primarily of ammonium perchlorate as the oxidizer, powdered aluminum as the metallic fuel, and PBAN (polybutadiene-acrylic acid-acrylonitrile terpolymer) as the polymeric fuel binder. A small amount of iron oxide is added to increase the burning rate. Ingredients are mixed with a curing agent and poured into the cases of the four major segments of the motor, the forward, two center and the aft casting segments. The propellant then is heated in the cases at 57 degrees C for four days. This cures the propellant into a rubbery material somewhat the consistency of a typewriter eraser.



A Piece of the Shuttle's Solid Rocket Motor—Casting segments of the solid rocket motor at the Thiokol Corp., at Brigham City, Utah. The largest such motor ever developed for space flight was fired successfully for the first time recently. The mandrel shown in this photo will be used for making the center segments of the motor.

Each segment is moved on a road transporter to the test site where the segments are joined horizontally, a task which required special handling equipment and fixtures.

Flight motors are to be transported by rail, one segment per special railcar, to the Kennedy Space Center, where the segments will be joined vertically in the vehicle assembly building. Later, deliveries will be made to Vandenberg Air Force Base, Calif.

Nuclear "Pumping" Technology Greatly Increases Laser Output

NASA researchers recently produced a nuclear-pumped laser power output 100 times more powerful than any previously reached with noble or inert gases, achieving 3.5 watts in a volume of only one cubic centimeter. The objective of this basic research is to develop a capability for efficient production and transmission of large quantities of power in space.

Experimental results demonstrated a major advance in nuclear-powered laser technology, converting the kinetic energy produced by splitting atoms directly into photons or light energy in the form of laser beams. And this is accomplished without the energy-wasting intermediate step of first converting heat to electricity.

In this experiment, conducted at NASA's Langley Research Center, neutrons caused fissioning or splitting of the Helium-3 isotope into a proton and triton. These particles, in the presence of argon atoms, in turn caused lasing or the production of the beam of energy (light) at a wave length of 1.79 micrometers.

So efficient is a laser beam in space as an energy conductor, that it is often called a "superconductor." Additionally, laser transmitters and receivers measure only a few tens of meters in diameter compared to kilometers for similar microwave equipment.

High-powered laser beams could have a wide range of uses in space. For example, laser-powered orbital transfer vehicles could carry payloads into geo-synchronous orbit from Earth. They also could connect central space power plants with settlements, materials processing centers and scientific operations in Earth orbit.

Two SRBs will be used on each Space Shuttle launched. The SRBs will be jettisoned on burnout at an altitude of about 43.5 kilometers for descent into the ocean by parachute. They will be towed to shore, refurbished, refueled and reused. Each is designed for a minimum of 20 flights.

New NASA Wind Tunnel to Be Constructed

The site of a unique national wind tunnel facility was dedicated at NASA's Langley Research Center in July.

Principal speaker at the dedication was Dr. John J. Martin, Assistant Secretary of the Air Force for Research and Development. Donald P. Hearth, Langley director, introduced Dr. Martin, and Oran W. Nicks, Langley deputy director, was master of ceremonies.

A long line of aircraft that have benefited from Langley research in the transonic speed range (the range that crosses the sound barrier) were on display during the day of the ceremony.

The display aircraft included a giant B-747 freighter; a wide-bodied DC-10 passenger plane; three Air Force fighters, (F-14, F-15 and F-106); a Learjet business aircraft; Langley's B-737 flying laboratory; a T-38 jet trainer; and a UH-1H helicopter with special rotor tips.

The new wind tunnel, called the National Transonic Facility (NTF), is being built at Langley because the center has a highly experienced staff of aeronautical research specialists, and because of Langley's 60-year history of major accomplishments in transonic aerodynamics.

To be completed in 1980, the tunnel will be used for major transonic research by NASA and the Department of Defense. About half of the NTF's occupancy will be allocated to other government agencies, private industry and the scientific community.

Estimated cost of the completed facility is $85 million.

Unique in the world, the NTF will allow the United States to maintain its leadership in high-performance commercial and military aircraft, and to develop future transport planes that will conserve fuel much more efficiently than some of the aircraft presently in use.

The new tunnel uses cryogenic gas (extremely cold nitrogen) to allow testing of aircraft models in as realistic as possible simulated flight environments. The nitrogen gas, cooled to temperatures as low as minus 300 degrees F., will produce the simulated Mach (speed of sound) numbers and density ratios to allow accurate simulation of full-scale aircraft characteristics for many classes of future aircraft.

Transonic air flows are especially complex because of the interaction of local flows that accelerate to form shocks and turbulence just below and above the speed of sound.

The NTF will provide more than 10 times the capability available in existing transonic tunnels.

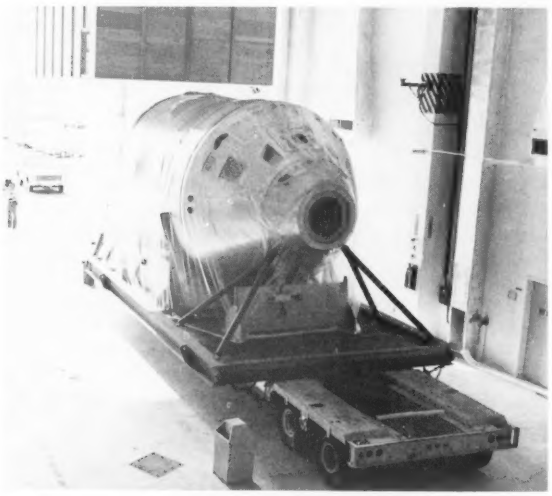
NASA-University Cooperation—Dr. Robert A. Frosch, NASA Administrator, signs contract establishing the NASA/Florida State Technology Applications Center, a jointly funded project of the NASA Technology Utilization Office and the State University System. Present are Dr. E. T. York, Jr., Chancellor of the State University System (left) and Congressman Don Fuqua of Florida, Chairman of the House Space Science and Applications Subcommittee. The new center will be operated by the Florida State University System in cooperation with the Florida Department of Commerce. Its purpose is to assist Florida business, industry and state agencies in solving technical problems by computer searches of the NASA-operated technical data bank which contains references to more than 10 million documents. The center will be located at the University of Florida in Gainesville, with field offices throughout the state. The NASA technology utilization program is designed to foster the transfer of NASA-developed technology into other sectors of the national economy. It already operates a nationwide network of six industrial applications centers and a second state technology applications center in the state of Kentucky.

Prospectus

International Teamwork

Last May 6, NASA's Deputy Director Dr. Alan M. Lovelace signed an agreement between NASA and the Academy of Sciences of the Soviet Union on further cooperation in manned space flight. The agreement came into effect on May 11 when it was signed by the Soviet Academy's President, Anatoliy P. Alexsandrov. It provides for studies in two major areas: (1) joint operations of the Shuttle/Soyuz/Salyut spacecraft for scientific and applications objectives of merit; and (2) the objectives that might be served by a space platform and the feasibility of developing such a platform bilaterally or multilaterally.

Two study groups on the Shuttle/Salyut prospects are to report back their recommendations for review, they hope by the end of 1978. Their goal is to complete preliminary proposals on the scientific objectives of the international space platform within one year after beginning work. The agreement thus is designed to capitalize on the scientific and operational capabilities demonstrated by the highly successful Apollo Soyuz rendezvous and docking mission in July 1975 for major cooperative space projects in the future.



U.S.-Soviet Space Displays—The engineering test model of the Apollo command and service module as it was crated at the Kennedy center for shipment to Moscow where it will become part of an Apollo Soyuz Test Project exhibit at the Soviet Academy of Sciences. An exchange agreement between the Soviet Union and the Smithsonian Institution's National Air and Space Museum provides for a Soyuz to be displayed at the American museum.

The signing of this agreement obviously represents further progress in international cooperation in space, but it also should have great value as a needed reminder of the extent of that cooperation, past, present and future.

In another U.S./USSR program, NASA and the Soviet Hydromet Service are conducting a rocketsonde cooperative project near NASA's Wallops Flight Center. U.S. researchers are launching their rockets from the Wallops center; the Soviets launch theirs from the research vessel *Akademik Korolov* offshore, in a series of tests running from Aug. 4 to 17. (See page 11 for additional information about this project.)

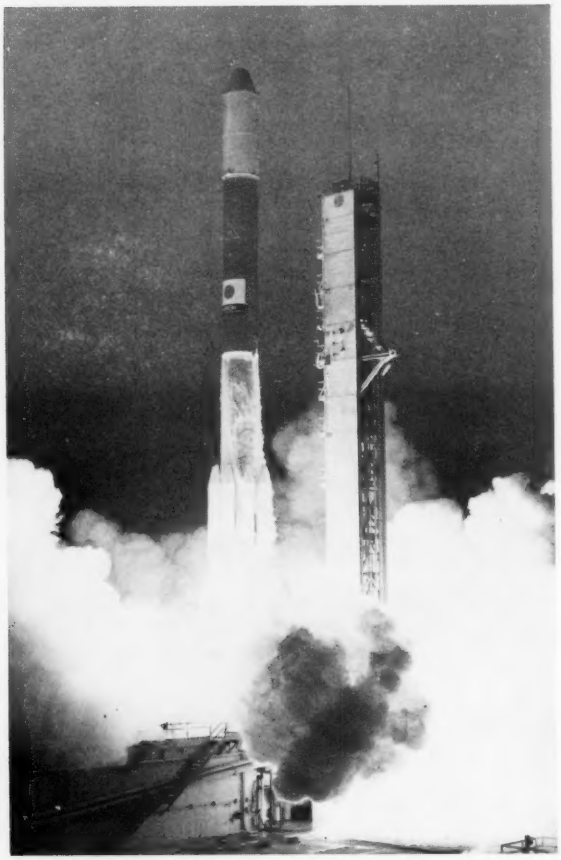
NASA is clearly directed by Congressional mandate to conduct space activities "so as to contribute materially to . . . cooperation by the United States with other nations and groups of nations . . . and in the peaceful application of the results of that cooperation."

In accordance with that mandate, extensive international activities in space have been developed under hundreds of specific agreements involving almost all aspects of NASA's programs. A large part of this activity consists of making available launch vehicles and spacecraft on a cooperative or reimbursable basis to place in space the satellites or satellite experiments of other nations, but it extends into many other areas as well.

Perhaps the most current and best known examples are the development of the $600 million Spacelab for use with the Shuttle, funded by 10 member nations of the European Space Agency, and the simultaneous development by Canada of the Shuttle's remote manipulator system.

Still another area of broad international involvement is Landsat with its broad capabilities for the survey and management of natural resources. Some 130 countries have purchased Landsat data and seven have signed agreements to establish ground stations for the direct reception of Landsat information. Others have shown an interest in similar participation in the Landsat program.

NASA's ATS-6 satellite, after a year of broadcasting instructional TV programs prepared in India to some 5,000 remote villages, was used in a joint NASA-AID project to transmit programs of special film and live two-way discussions between U.S. experts and local authorities, to 27 countries in Asia,



Japan's GMS Spacecraft—The Geosynchronous Meteorological Satellite seen at launch from the Kennedy Space Center in mid-July.

Africa, the Middle East and Latin America. The presentations showed how space technology could be applied for the benefit of developing nations. NASA is working with AID on follow-on activities of the same kind.

In a similar project, the joint U.S.-Canadian Communications Technology Satellite (CTS) currently is broadcasting TV and other material at high power to isolated communities in Arctic and sub-Arctic regions of Canada and Alaska.

A NASA co-sponsored International Conference on the Stratosphere at Utah State University last September was one of many activities carried out to broaden participation in our upper atmosphere and ozone studies. These have resulted in the contribution of French and Canadian instruments and Australian and New Zealand ground observations to NASA's airborne and balloon studies. Several foreign scientists are regular members of the NASA Stratosphere Research Advisory Committee. In addition, Italy has agreed to build two spacecraft carrying U.S., Italian and German solar-terrestrial weather experiments and launch them from the Italian equatorial San Marco platform in the Indian Ocean in 1979. The Italian SIRIO was launched by NASA in August for the investigation of various space phenomena. In July, NASA launched Japan's GMS (for geosynchronous meteorological satellite).

Two Helios solar probes, built and largely instrumented by Germany, were launched by NASA in late 1974 and early 1976. Their findings are being correlated with other data of the International Magnetosphere Study.

We are very near formal agreement with the Netherlands on a cooperative project for an infrared astronomy satellite in the Explorer Program which will conduct the first detailed satellite-borne stellar infrared survey, with the United Kingdom providing the primary ground station.

Discussions with the European Space Agency have led to virtual agreement on a European contribution to the 2.4-meter space telescope, approved July 30, 1977 by the Congress. The European contribution will be substantial, in both spacecraft hardware and in support of operations. In return, European astronomers will have a commensurate portion of the observing time on the telescope.

Another prospective cooperative activity to which we can look forward fairly soon, since the necessary funding has been included in our budget for 1978, is a satellite-assisted global search and rescue capability with a potential for saving a great many lives at a significantly reduced cost. Discussions concerning Canadian, Soviet and French participation are well advanced.

In addition, studies are underway on the active magnetospheric particle tracer experiment and the Jupiter orbiter probe with Germany, and the out-of-ecliptic mission with the European Space Agency.

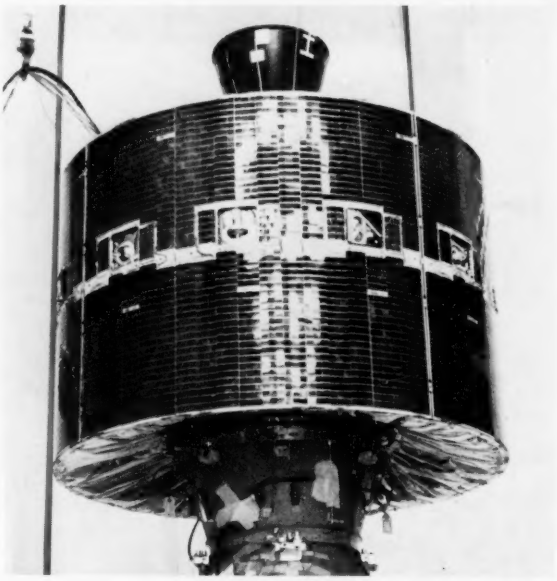
One of the material benefits to our country from all this activity is a major contribution to a favorable balance of payments. Foreign purchases of space

hardware and Earth resources (Landsat) data, reimbursable launches and the dollar in-flow generated by cooperative space projects will have added an estimated total of $1.5 billion to the plus side of that balance in the period 1968-78.

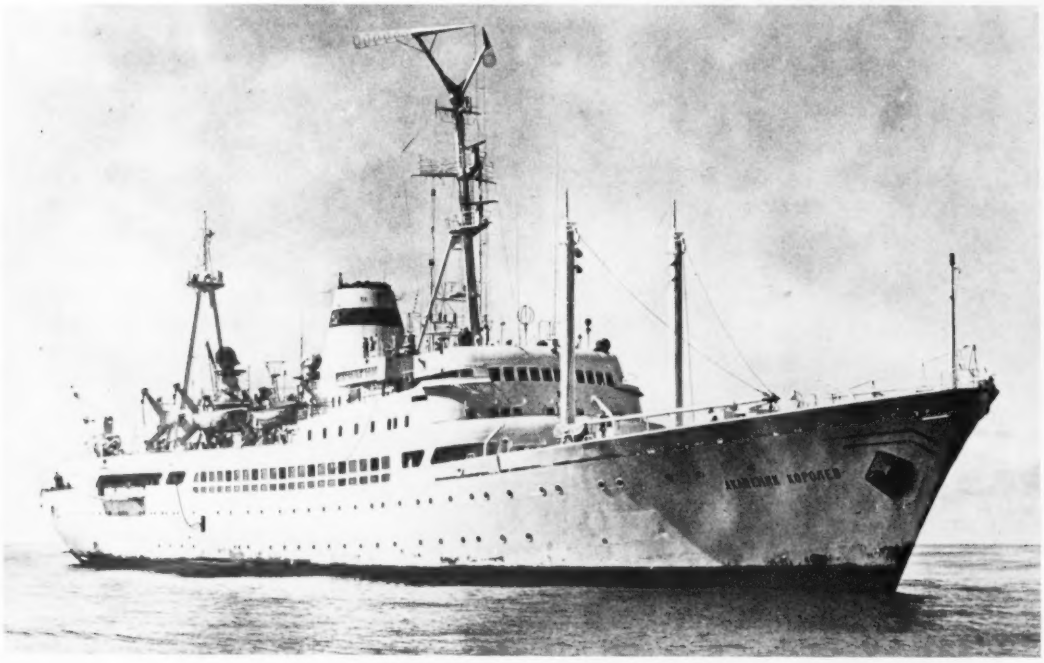
Future international cooperation in space is particularly significant when it involves the United States and the Soviet Union. In this important area, arrangements have been made for Soviet delivery to NASA of seven lunar soil samples from their Lunar 24 sample return mission and plans have been completed to fly U.S. experiments on a Soviet biological satellite later this year, as was done in November 1975.

Apollo 11 Astronaut Michael Collins, who should know, has written "If the Earth as seen from space has one elemental quality, it is fragility. From 200,000 miles out, the Earth seems pitifully small and terribly fragile . . ."

The continued pursuit and expansion of realistic international cooperation in space is perhaps the most effective way of protecting and preserving the fragile globe on which we live.



Italian Satellite—The first Italian experimental communications satellite, SIRIO, being made ready for launch at the Kennedy center. SIRIO went into orbit Aug. 17.



Russian Research Vessel—The Soviet hydrometeorological ship *Akademik Korolov*, which is taking part in U.S.-USSR rocket experiments off Virginia.

Space Shuttle Engine "Controlled" by Complex Device

A highly sophisticated "brain" made of more than 13,000 parts, 10,000 wires and 2,000 mechanical parts designed by Honeywell for use aboard the Space Shuttle weighs only 95 kilograms and is about as wide as the seat of a chair (53 by 35 centimeters). It works so rapidly that automatic self tests and control of all system components take place every 20-thousandths of a second—quicker than you can blink your eye. Despite all these intricacies, it uses only as much power as the average household lamp or TV set.

Those are some of the features of the Space Shuttle's main engine controller, a unique electronics package that works in conjunction with engine sensors and actuators to run the Shuttle's powerful main rocket engines. It assimilates all pertinent data and "tells" the robot engines what to do and how to do it.

Microelectronics—miniaturized electronic devices which perform functions far outweighing their diminutive stature—are used in the controller to meet the severe weight and space limitations, and to achieve high reliability.

The controller operates in a severe environment.

Complex Power-Supply Module—This object is part of one of the 13 flight controls designed by Honeywell to guide Space Shuttle during test flights this summer. Production coordinator O. C. Houston examines the unit at Honeywell Avionics Division plant, St. Petersburg, Fla.

Mounted on the throat of the rocket engine, it is subjected to extreme heat and cold: from —44 degrees C during chilldown prior to launch, to the high temperature of launch, and then extreme cold when in space sometimes for several weeks.

Because of strong vibrations during lift-off, it has been tested to withstand vibration up to 2215 g's—equal to more than 900 kg of force exerted on a 90 kg person.

The complex unit took three years in design and fabrication stages at Honeywell's Avionics Division in Minneapolis.

Thousands Apply for Space Shuttle Duty

More than 8,000 people have applied for the 30 to 40 astronaut positions on the Space Shuttle for which NASA has been recruiting during the past year. To be eligible, applications had to be postmarked before midnight June 30, 1977. Many waited until the last day to apply and total application numbers were still being tallied in mid-July.

The latest count indicates that 8,037 men and women applied for the astronaut program. In the mission specialist category 6,735 individuals applied and 2,302 applied in the pilot category. Women applicants for the two categories numbered 1,142.

Thirty to 40 of the candidates will be accepted for a two-year training and evaluation period at NASA's Johnson Space Center. At least 15 candidates for pilots and 15 others for mission specialists will be notified of their selection by December, and will be asked to report for duty at the Johnson center in 1978. Final selection as an astronaut will depend on satisfactory completion of an evaluation period.

The astronaut selection board at the Johnson center in July was in the process of narrowing the list to about 140 of those best qualified in each category for preliminary screening and physicals at Johnson.

Some 25,000 inquiries were received after the program was announced a year ago—of these, 20,440 persons received application packets.

At present, 30 persons are available for crewing work aboard the Space Shuttle, including nine scientists. Of these, 27 are astronauts assigned to the Johnson center and three hold government positions in Washington, D.C.

The reusable Space Shuttle will replace virtually all of this nation's space launch vehicles. Shuttle missions could include deploying and retrieving satellites; servicing satellites in orbit; operating laboratories for astronomy, Earth sciences, space processing and manufacturing; and developing and servicing a

permanent space station.

Launched like a rocket, the Shuttle will perform Earth orbital missions of up to 30 days, then land like an airplane and be refurbished for another mission. Pilot astronauts will control the Shuttle during launch, orbital maneuvers and landings and be responsible for maintaining vehicle systems. Mission specialist astronauts will coordinate orbiter operations in matters related to flight planning, consumables usage and other factors that affect payload operations. At the discretion of the payload sponsor, mission specialists may assist in the management of payload operations and may, in specific cases, serve as payload specialists. They will be able to continue in their chosen fields of research and to propose, develop and conduct experiments.

Shuttle crews will consist of a commander, a pilot and perhaps a mission specialist and payload specialists. Payload specialists need not be NASA employees.

Conserving Fossil Fuels

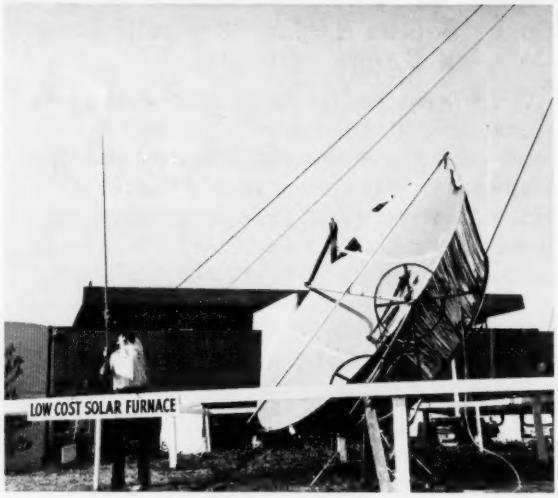
A recently-invented solar energy collector, so simple it can be easily constructed, can produce a peak output of 300,000 BTUs (heat transfer units) per hour, enough to provide heating, air conditioning and hot water for several large buildings.

A concave aluminized mylar reflector, a cone-shaped absorber and a Sun tracking system are the major components of the new invention. One of the inventors, Whitt Brantley Jr. of NASA's Marshall Space Flight Center, said that working fluid temperatures of 94 to 538 degrees C are achievable at efficiencies of 50- to 70-percent of the direct solar radiation. He projects the cost in mass production as low as $5.00 per square foot for units 6.7 to 15 meters in diameter.

In a specific application being considered for the Marshall center, a 15-m unit, placed across existing steam lines, can save approximately 3,800 litres of fuel oil per year. Using return water from the steam lines at 18 to 76 degrees C, the unit will produce 14 kilograms per square centimeter steam to return to the lines.

As designed by the inventor, the unit would produce steam during hours of sunlight, and when sunlight is not present, would automatically signal the conventionally-fueled steam plant to commence operation.

The cone-shaped collector, mounted above the center of the concave reflector, contains coiled pipe through which the water flows to be heated. At this point, all of the Sun's rays striking the 15-m diameter reflector are concentrated into the absorber's 1.2-m diameter opening.



Big Energy Saver—Demonstrating the power of energy from the Sun, a Marshall center engineer holds a steel can at the end of a pole which was ignited by reflected rays concentrated by the reflector shown at right. Inventors claim the new system can save many thousands of gallons of fuel oil annually, if used for industrial processes.

According to Brantley, the invention is expected to provide a solar energy option for applications where working fluid temperatures over 95 degrees C. are required. These applications would include residential and commercial heating and cooling; industrial processes such as steam cleaning, baking, cooking and canning; and electricity generation.

This collector represents a feasible means for conservation of conventional fuels. It has been proposed as a facilities project for connecting to existing steam lines at the Marshall center where it would supply heating, hot water and cooling for the building 4250 complex (five buildings), reducing the steam system dependence on the current fossil fuel-fired source.

Brantley and Robert W. Rood, also of the Marshall center, collaborated in inventing the reflector for this new energy collector and a patent has been approved for issue. Brantley was granted a patent for the con-shaped absorber and he and Billy D. Lawson, of Marshall Center, were awarded a patent for the Sun tracking system.

Licensing information regarding the patents is available from the Office of Chief Counsel, Marshall Space Flight Center, Ala. 35812.

Facelift at KSC for Space Shuttle Launch

More than two years have passed since launch complex 39 at NASA's Kennedy Space Center reverberated with the sound and fury of a rocket catapulting men into space from the Florida facility. And it will be two more years more before the Space Shuttle climbs into the sky on its first orbital flight.

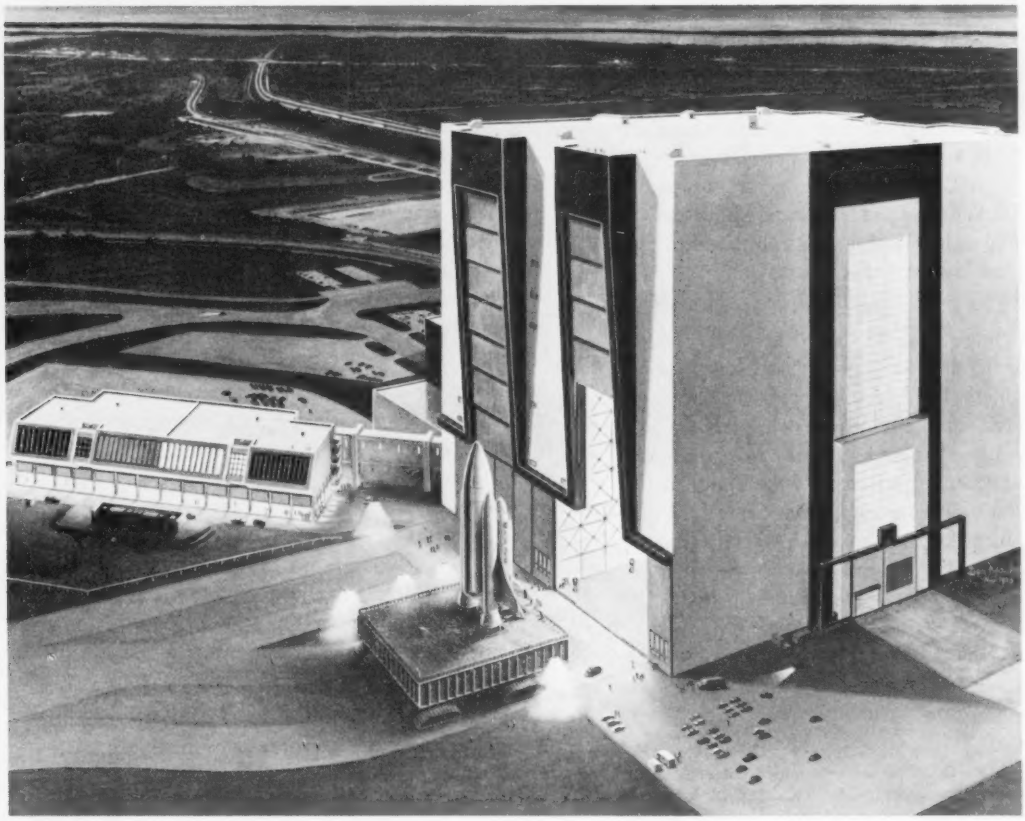
Many of the sprawling and massive facilities at the center—built in the first place for Apollo journeys to the Moon—have already been reshaped for their new roles in the Space Shuttle era.

The Space Shuttle is a new breed of space machine which is launched like a rocket, maneuvers like a spacecraft and lands like an airplane.

KSC was selected as the primary launch and landing site for the Space Shuttle in 1972 and construction has been aimed at preparing to receive the first Shuttle flight hardware in 1978 and to support the first manned orbital flight in 1979.

Among factors leading to the Kennedy center's designation as the prime Shuttle site was the existence of complex 39, whose structures are readily adaptable to Shuttle launch and servicing requirements. To keep costs down, planners were directed to take advantage of existing buildings that could be modified. New facilities were to be built only when a unique requirement existed. The existing physical plant was so adaptable that only two major new facilities were required. These were:

- The orbiter landing facility to which the Shuttle orbiter will return—one of the largest runways in the world—is located northwest of the vehicle assembly building. It is roughly twice as long (4.5 km) and twice as wide (91 m) as the average commercial landing strip and it has a 300-m safety overrun at each end. Its equipment includes a microwave scanning beam landing system to guide the orbiter to an automatic landing on its return from a mission in space.



Getting Ready for the Big Action—A transporter moves a flight-ready Space Shuttle vehicle, aboard a mobile launcher, out of the vehicle assembly building enroute to launch site in this artists's conception of future Shuttle activities at the Kennedy center.

• The orbiter processing facility is located in the heart of complex 39 and connected with the landing facility by a 3.2-km towway. The OPF essentially is an aircraft "hangar" with two high bays in which orbiters will be checked out and serviced immediately after landing. It is here, protected from the elements, that ordnance and residual fuels will be rendered safe, flight and landing systems refurbished, and payloads removed and installed. A technological "facelift" has been undertaken to prepare the existing facilities for their new roles.

• The vehicle assembly building, site of assembly for the Saturn V/IB rockets used in the Apollo, Skylab and Apollo Soyuz programs, is being modified for the assembly of the Space Shuttle in two of its four high bays. The remaining two high bays will be used for processing and staging the Shuttle's solid rocket boosters and external tank.

• The launch control center, the "brain" of the complex, is being fitted out with the highly automatic launch processing system (LPS) developed for Shuttle checkout and launch. Two of four firing rooms are being equipped with LPS consoles and associated equipment. So sophisticated is the new system that only about one-tenth of the manpower required for Apollo will be needed in the firing room to check out and launch the Space Shuttle—45 persons as compared to more than 450 in the earlier launches. And the final countdown for the Space Shuttle is expected to take only 2½ hours as compared to the 28 hours needed for the final countdown for an Apollo/Saturn V.

• Launch pads 39 A and B are undergoing major changes. With the exception of the six fixed pedestals that support the mobile launcher platform, the structures on the surfaces of these twin pads (originally built for Saturn launches) will be removed or relocated. The upper portions of the umbilical towers from the mobile launcher platforms are being removed and installed at each pad to serve as fixed Shuttle service and access towers. With the exception of Spacelab—the large space laboratory being built by the European Space Agency—payloads may be loaded into the Shuttle orbiter at the launch pad from the payload changeout room. The payload changeout room is a "white room" structure mounted on a semi-circular track extending from the Shuttle service and access tower. The room is "swung" along its track to its park position prior to launch. The Saturn Mobile Launchers are undergoing major changes to adapt them for the Space Shuttle. The most striking visual changes involve removal of the launch towers and their cranes from the platform. The need for these has been eliminated on the mobile launcher platforms by installation of permanent launch towers on the pads.

The single opening in the center of the mobile launcher platform is being replaced by three openings to permit exhaust gases from the orbiter's main engines and two solid rocket boosters to escape during liftoff.

The ponderous transporters bearing massive loads on a back the size of a baseball diamond will be used to move mobile launcher platforms with the assembled Space Shuttle between the assembly building and the two launch pads at complex 39. These twin giants originally were adapted from strip-mining machinery used to carry Saturn V/Apollo flight hardware around complex 39—both have amassed odometer readings in excess of 800 km. The transporters are expected to be able to perform their load-carrying chores throughout the life of the Space Shuttle program.

Much of the construction and modification work has already been completed. The eventual cost of the entire project will approximate $240 million, less than a quarter of the cost of building the Spaceport for Project Apollo in the 1960s.

Huge Test Structure Delivered to MSFC

The Space Shuttle testing program has helped create a situation similar to the one in which a man built himself a yacht but could not get it out of his basement. The test article, consisting of a liquid hydrogen tank, intertank section and liquid oxygen tank simulator, will hang from the upper reaction structure in a giant stand. Loads and stresses applied to it will be "felt" by the structure and recorded by instruments.

Teledyne Brown Engineering Co. has built for NASA's Marshall Space Flight Center a structure so big that part of a wall must be removed to get it from the building. Just such an event was foreseen by the manufacturer, though, and the wall was built so that it could be removed and replaced quickly.

The 124,500-kilogram (137-ton) structure blocked some roads briefly as it was moved to the Marshall center. The "upper reaction structure" is 15 meters in diameter and 3¾ m high.

The structure is to be installed by Bendix Corporation personnel at the 46-m (150-ft.) level on the giant test stand modified for tests of the Space Shuttle external tank structural test article.

The upper reaction structure, resembling a mammoth doughnut, was moved from Georgia to Alabama on a special "low-boy" trailer with 32 wheels, plus a 16-wheel dolly at the forward end.

Satellite Tracking by Laser in Australia

Australia's Minister for Science, Senator J.J. Webster, recently announced that consideration is being given to installing a NASA satellite tracking laser in western Australia for geodetic research, mapping and use in earthquake prediction. The technical feasibility of a temporary laser installation for NASA is under study by the Australian Departpartment of Science.

Webster said it is proposed that NASA operate the laser for about a year, beginning around 1978. No formal commitments so far have been made by either Australia or the United States.

The installation would be part of a network of tracking lasers to be established for various periods at locations around the world. The lasers are able to accurately measure the range of a satellite by determining the length of time during which pulses of light travel to a satellite and are reflected back to Earth.

In conjunction with NASA's Seasat (to be launched in 1978) and other lasers in the global network—together with existing tracking lasers such as the one at the Australian Orroral Valley Satellite Tracking Station near Canberra—the proposed laser in western Australia will provide measurements in support of geodetic research, including refinement of the measurement of the shape of the Earth and mapping of the oceans. Webster said it also would provide accurate information of great interest to geologists and geophysicists for possible use in earthquake prediction studies.

Thunderstorm Scientists Meet at KSC

In 1976, leading meteorologists and atmospheric physicists from across the United States and abroad gathered at NASA's Kennedy Space Center for the most extensive study ever conducted on the electrical characteristics of thunderstorms. In the summer of 1977, the center again was host to the researchers. The event was called "TRIP 77" (for Thunderstorm Research International Program 1977).

The 1976 program resulted in a wealth of new data which help explain the phenomena that cause electrical charges in cumulo-nimbus cloud formations, electrical discharges within and between clouds, and from clouds to the Earth's surface. In addition, the 1976 program laid the foundation for subsequent studies this year and in 1978.

Twenty-one principal investigators with their associates, representing many of the country's leading educational institutions and research organizations, were involved in the study during the summer, making up a force of 85 experimenters.

Resources of KSC associated with lightning and some Air Force Eastern Test Range instrumentation were used to provide data required by the experimenters. Those included KSC's 207-square-kilometer electric field measuring system (developed during the Apollo program for detecting the buildup of electrical charges in thunderclouds that might interfere with space vehicle launch operations) and NASA-6, KSC's C-45 instrumented meteorological aircraft used previously in lightning studies.

(*Continued on following page*)

Congressional Visitor—Senator Adlai E. Stevenson (right), Chairman of the Senate Subcommittee on Science, Technology and Space, examines an infrared photo of the Washington, D.C. area. Acting director Clarence A. Sylvertson of the Ames Research Center points out landmarks. Senator Stevenson visited Ames in July for a series of technical briefings. The infrared photograph was made by a NASA Earth Resources Survey Aircraft (Lockheed U-2) at heights of 12,000 kilometers.

Also used were weather radar and KSC's storm detection meteorological radar, including camera and digitized automatic radar tracking systems; the Cape launch pad lightning warning systems; a weather information network display system; a satellite imagery acquisition system with equipment for processing weather satellite pictures; an automatic picture transmission recording system; and timing and camera systems, both optical and TV.

The National Oceanic and Atmospheric Administration's Geosynchronous Operational Environmental Satellite and a Department of Defense weather satellite provided imagery for scientific use and NOAA's National Weather Service office at KSC was manned to provide forecasting and other meteorological services.

Among the experiments which covered almost every imaginable subject of study, were: electric field measurements of discharges within storm clouds; within active thunderclouds; location of the lightning charge "center" and its correlation with the storm's physical structure; measurement of the waveshapes of lightning strokes; determination of the electrical inflow and outflow of clouds; measurement of lightning stroke velocities near the ground, with their corresponding electric and magnetic fields; study of the evolution of lightning activity at KSC; and establishing a correlation between airborne and ground lightning test measurements.

In addition to the investigations conducted by the scientific community, KSC carried out two of its own experiments during the lightning study. The first involved a lightning triggering project to initiate and direct natural lightning to a specific target. This capability will allow KSC to verify, under controlled conditions, the protection of a structure against lightning and its associated ground support equipment —but without waiting until lightning actually strikes the location.

KSC also operated its lightning detection and ranging system, as it did in 1976. The objectives of the system are to locate electrically active areas of a cloud, map the spacetime history of the electrical discharges, determine the physical relationship between electrically active areas and rain areas of a cloud, detect and locate cloud to ground lightning strikes and determine associated wave form characteristics.

Organizations participating in the project and principal investigators were:

NOAA Environmental Research Laboratory (three projects)—Dr. Heinz Kasemir, William L. Taylor and Dr. David Rust.

New Mexico Institute of Mining and Technology (two projects)—Dr. Marx Brook and Professor Charles B. Moore.

Rice University—Dr. Arthur A. Few.

University of Florida (two projects)—Dr. Martin A. Uman.

State University of New York at Albany (two projects)—Dr. Richard E. Orville and Dr. Bernard Vonnegut.

University of Arizona—Dr. E. Phillip Krider.

University of Miami—Dr. Robert M. Lhermitte.

Massachusetts Institute of Technology—Dr. Ralph Markson.

NASA Goddard Space Flight Center—Dr. David M. Levine.

NASA Marshall Space Flight Center—P. Marrero.

NASA Johnson Space Center—Donald D. Arabian.

Stanford Research Institute—Dr. J. Nanevicz.

Federal Aviation Administration, Department of Transportation (two projects)—Frank Coons and R. Kalafus.

Air Force Flight Dynamics Laboratory (two projects—Lt. Robert Baum and V. Mangold.

Pennsylvania State University—Hans Panofsky.

Jack Carter Tours Langley—Langley center director Don Hearth greets President Carter's son, Jack, who visited Langley in June. Carter toured several facilities, including the differential maneuvering simulator, the machine shop and the fabrication shop.

Did You Know?

A new book entitled "Space Settlements: a Design Study" (NASA SP-413), recently was published by NASA's scientific and technical information office. It describes in vivid terms and illustrations the construction and operation of permanent settlements in space where as many as 10,000 people at some future time may work, raise families and live out their lives. The 185-page volume is based on a study sponsored by the American Society of Engineering Education and NASA, held at the Ames center and Stanford University, in which 31 engineers, scientists and students participated. The book is priced at $5.00, on sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20301 (stock number 033-000-00669-1).

James J. Modarelli of NASA's Lewis center recently designed a new seal for the city of Middleburg Heights (Ohio). It was presented to the community during the Middleburg Heights Jaycees' 10th anniversary. Modarelli has been with the Lewis center since 1948 as an artist-designer.

A study of Landsat imagery as the satellite passed over Alaska in successive orbits has revealed a heavily fractured bowl some 12 kilometers wide that may have been caused by the fall of a giant meteorite, according to geologists. The object, which may have weighed about 50 metric tons could have fallen some time during the latter part of the last Ice Age (some 100,000 years ago) according to an analysis presented by Jan Cannon of the University of Alaska at Fairbanks.

The Dryden center's cafeteria water will be heated by a solar system beginning this fall. The system, which costs about $56,000, is now under construction. It will include three solar collector panels to be built in a new parking lot nearby. Water will be heated in the panels and then piped to two 315-liter tanks in the kitchen area of the cafeteria. The Dryden solar heating unit is one of the smallest of several such installations being built at several NASA facilities around the country under a $1.8 million grant from ERDA.

Two novels recently were published by people at NASA's Jet Propulsion Laboratory. One is a science fiction novel by space technician Ed Gregory, entitled "Strange Signature from Space." Gregory has worked on weather and communications satellites and has had important roles in many of JPL's space missions. The current "So Loud the Torrent," a mountainman adventure novel was written by R. C. House of JPL's public affairs office. With JPL since 1969, House is editor of "Universe."

"What's New on the Moon" (EP-131), a NASA educational publication about Moon rocks and lunar science, has received a "Blue Pencil" award as the best U.S. Government publication produced in 1976. The 24-page booklet, written by Dr. Bevan M. French of the office of lunar and planetary programs, won first prize in a nationwide competition sponsored by the National Association of Government Communicators. The publication is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 at a cost of 70 cents. (Minimum mail order is $1.00.) ■ ■ ■

NSTL Awards $115,335 Contract—At signing of a Small Business Administration contract to the minority firm, Williams Wrecking and Construction Co. for exterior painting of 26 buildings are, left to right, James E. Davis, contracting officer; H. A. Paper, contract negotiator; Jerry Hlass, NASA's National Space Technology Laboratories manager; Dewey Little, industrial operations office; and B. H. Williams, president of the company.

Contractor News

RCA Service Co. has been awarded a $3 million NASA contract for engineering support of the NASA Communications Network. The Goddard center contract, which extends work RCA has done since 1971, contains two options providing a potential five-year contract totaling $8 million.

General Electric Co. of Valley Forge, Pa., was selected by NASA's Marshall center for negotiation of a contract for the Atmospheric Cloud Physics Laboratory. Negotiations, to be conducted on a cost-plus-award-fee contract, call for the design, development, fabrication, delivery and operational support of the protoflight ACPL for the first Spacelab flight. To be designed for multiple missions, the prototype ACPL, with software and spares, is to be delivered to the Marshall center by Oct. 1, 1979 and subsequently to the Kennedy center, launch site for the Shuttle in 1980.

Under a $150,000 NASA contract, **the Illinois Institute of Technology Research** in Chicago is establishing a manufacturing technology applications team to review NASA-developed technology and identify processes that have manufacturing applications. The new team will work with companies, industrial associations and professional groups. The research augments efforts of NASA's Technology Utilization Office.

Ball Brothers Research Corp. of Boulder, Colo., has been selected by NASA for final negotiation of a contract for a telescope system for the infrared astronomy satellite project. The contractor's proposed cost, exclusive of fee, is about $13.8 million. The project is a cooperative U.S.-Netherlands space project whose mission is to perform an infrared survey of the entire celestial sphere. The Ames center has responsibility for the system. NASA's Jet Propulsion Laboratory has overall U.S. project management responsibility.

The Boeing Commercial Airplane Co. of Seattle, Wash. has won a NASA contract to design, ground-test and certify composite elevators for the Boeing 747 aircraft. The contract is one of several being established with commercial transport manufacturers to demonstrate the weight savings of composite components as part of NASA's aircraft energy efficency program. The program is aimed at the application of advanced aeronautical technologies that will increase by some 50 percent the fuel efficiency of modern transports. Costs of the definitive contract will be shared, with the government contributing $8 million and the contractor $890,000.

Lockheed Missiles and Space Co. of Sunnyvale, Calif., and **Perkin-Elmer Corp** of Danbury, Conn., have been selected by NASA for final negotiations leading to the award of contracts for the development of two major elements of the Space Telescope. The contracts, totaling more than $131 million, will be awarded in October for a period of performance through 1983.

Six firms have responded to requests by the Kennedy center for proposals on a printing, reproduction and documentation support services contract. Responses were from **Data Graphics Services, Inc.** (Fort Lauderdale, Fla.), **Information Services Inc.** (Cocoa Beach, Florida.), **Kaufman and DeBell Printing Inc.** (Syracuse, N.Y.), **McGregor-Wernor, Inc.** (Washington, D.C.), **Robinson's Printing Co., Inc.** (Huntsville, Ala.), and **Systems Publications, Inc.,** Seat Pleasant, Md.) Effective date of the contract will be Dec. 1, 1977 and the duration three years. ■ ■ ■

Black Students Win High Science Awards

A 12th grade San Diego student recently won a NASA award as well as the Grand Trophy for 1977 in a nationwide competition among science students. He is Jonathan Holman of the Patrick Henry High School, who received the award for his experiment in "Control Mechanisms in Blood Clotting."

For Holman, his research was a matter of personal challenge inasmuch as his family has a history of hemophilia. He received the award from an older brother, Jeffrey, who was the top prize winner in the competition last year and is now a student at Massachusetts Institute of Technology in Cambridge.

The scientific competition was held during the recent third annual spring conference of the National Consortium for Black Professional Development in Atlanta.

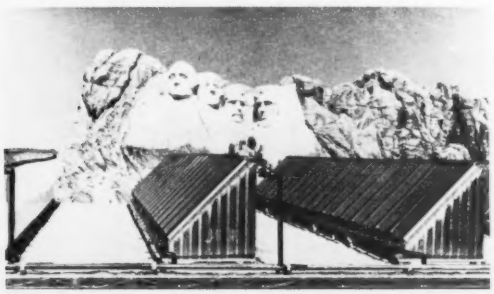
Others presented with NASA awards in the competition were: Lolita Smith, Corliss High School, Chicago; and Phyllis Brown and Robert Belcher, students at C. L. Harper High School in Atlanta.

Everett P. Colman, EEO officer at NASA's Lewis Research Center, who served as NASA coordinator for the program, said that the competition is part of NASA's efforts to increase and improve the number of qaulified minority persons with the scientific skills the space agency will need in future years.

Among NASA officials attending the award ceremonies were: Dr. Harriett Jenkins, Assistant Administrator for Equal Opportunity Programs; Curtis Graves, Director of Community Affairs; and Delores Hart, headquarters women's program coordinator.

Launches for 1977—Completed and Projected

Name	Launch Date	Vehicle	Range	Mission Remarks
NATO-3 B	Jan. 27	Delta	ETR	Second communications satellite in synchronous orbit to perform communications relay for NATO. Reimbursable.
Palapa-2	March 10	Delta	ETR	Back-up satellite for Indonesian domestic communications network. Reimbursable.
GEOS/ESA	April 20	Delta	ETR	ESA spacecraft to conduct scientific investigation of waves and particles in magnetosphere. Reimbursable. Failed to reach correct orbit.
Intelsat IVA-C	May 26	Atlas/Cen.	ETR	Improved communications satellite for Comsat. Reimbursable.
GOES/NOAA	June 16	Delta	ETR	Second operational satellite to provide continuous daytime and nighttime global cloud cover observations for NOAA. Reimbursable.
GMS-Japan	July 14	Delta	ETR	Geosynchronous Meteorological Satellite. Japanese portion of global network of geostationary environmental satellites. Reimbursable.
HEAO-A	Aug. 12	Atlas/Cen.	ETR	High Energy Astronomical Observatory to study energetic radiation from space.
SIRIO-I	Aug. 17	Delta	ETR	Italian project to investigate radio propagation, trapped radiation flux, magnetic field intensity and variation, and the primary electron energy spectrum. Reimbursable.
Voyager 2	Aug. 20	Titan III Centaur	ETR	Jupiter and Saturn planetary systems and the interplanetary medium out to Saturn.
Voyager 1	Sept. 3-23	Titan III Centaur	ETR	Same as above.
Intelsat IVA-D	Sept. 15	Atlas/Cen.	ETR	Follow-on series of improved communications satellites for Comsat. Reimbursable.
OTS/ESA	Sept. 9	Delta	ETR	Orbital Test Satellite. ESA experimental communications satellite. Reimbursable.
Navy Transit	Sept 27	Scout	WTR	Navy navigation satellite. Reimbursable.
ISEE-A/B	Oct.	Delta	ETR	NASA's international Sun-Earth explorer.
FLTSATCOM	Oct.	Atlas/Cen.	ETR	DOD fleet communications satellite.
UK-6	Oct.	Scout	WI	United Kingdom satellite to measure ultra-heavy cosmic-ray particles.
Meteosat	Nov.	Delta	ETR	ESA meteorological satellite. Reimbursable.



Collectors of Sunshine—The Mt. Rushmore National Memorial looks down upon solar collectors mounted on the top of the visitor's center. The collectors provide heat and air-conditioning fuel for the 674 sq.-meter structure. This is one of 59 solar energy projects being monitored for technical design and construction by the Marshall center, under ERDA's commercial solar energy demonstration program.

Patents for Inventions from NASA Research

The Office General Counsel, NASA headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer(s)	Title & NASA Docket	Patent No.	Installation
Lott W. Brantley, Jr., NASA/MSFC Robert W. Rood, NASA/MSFC	Pressure-shaped reflector apparatus	4,033,676	MSFC
George W. Luebering, General Eelectric Co. Cincinnati, Ohio	Blade retainer assembly	4,033,705	LERC
Theodore Flattau, Cutler-Hammer Ronald A. Lange, Inc., Ail Division John W. Mellars, Melville, Long Bernard J. Peyton, Island, N.Y. John M. Wolczok,	Wideband heterodyne receiver for laser communication system	4,033,882	GSFC
Mark R. Nichols, NASA/LARC	Dual cycle aircraft turbine engine	4,033,119	LARC
Arthur G. Birchenough, NASA/LERC	Sustained ARC ignition system	4,033,316	LERC
James D. Frost, Jr., The Methodist Carl E. Hillman, Jr., Hospital Houston, Texas	Snap-in compressible biomedical electrode	4,033,334	JSC
Edward F. Baehr, NASA/LERC	Corneal seal Device	4,033,349	LERC
Wayman N. Clotfelter, NASA/MSFC	Method for measuring biaxical stress in a body subjected to stress including loads	4,033,182	MSFC
George Sonnenschein, Faraday Lab. Danield McKeown, Inc., La Jolla, Calif.	Method for attaching a fused-quartz mirror to a conductive metal substrate	4,033,503	MSFC
Frank G. Arcella, Westinghouse Corp. Gerald G. Lessmann, Pittsburgh, Pa. Russell A. Lindberg, NASA/LeRC	Bimetallic junctions	4,033,504	LERC
Robert E. Cunningham, NASA/LeRC	Hydrostatic bearing supoprt	4,035,037	LERC
Sing H. Lee, Univ. of Calif., La Jolla, Calif. Arnold R. Shulman, NASA/GSFC	Method and apparatus for producing an image from a transparent object	4,035,062	GSFC
Maurice J. Argoud, Caltech/ Jack Jolley, JPL, Walter L. Walker, Pasadena, Calif.	Lightweight reflector assembly	4,035,065	NRLO
David S. Jacob, Beckman Instruments Inc., Advanced Technology Operations, Anaheim, Calif.	Pressure modulating valve	4,033,479	JSC

Two-time Winner—At the Johnson center, Edna D. McAnelly receives certificates from James Neal, director of JSC procurement (left) and H. T. Christman, small business specialist. McAnelly was singled out as the FY 1977 small business set-aside buyer whose cooperative efforts resulted in the "largest dollar volume" and "the largest number" of individual set-asides processed by a single buyer for the year. The awards have been presented for the past six years, usually going to two individuals.

Easy Rider—This slick, two-place aircraft incorporating NASA-designed technology was built with an investment of $6,000 and six months time by John Murphy of the Kennedy Space Center's technology utilization office. Designed by Bert Rutan of Mojave, Calif., the plane uses the winglets conceived by Dr. Richard Whitcomb of the Langley Research Center. The winglets—vertical fins on each wing tip—increase aircraft efficiency by unwinding wingtip vortex and reducing drag. The efficiency gain is estimated at about eight percent. The sporty airplane cruises at 322 km/h, has a range of about 1,237 km and gets a penny-pinching 61 km per gallon of gas. Powered by a 100-horsepower Continental aircraft engine mounted as a "pusher," the Verieze ("very easy") is built of fiberglass and styrofoam. It weighs only 300 kg and has a climb rate of 457 m per minute. Pitch control is provided by long, narrow front-mounted canards rather than the conventional elevators in the tail assembly. The plane does not come as a kit; Rutan provides only plans and guidance. "It's a great plane to fly," said Murphy of his creation.

1977 Galileo Memorial Scholarship Awards—James Johnsen (second from left), a senior at Monta Vista high school in Cupertino, Calif., won the 1977 American Institute of Aeronautics and Astronautics/Ames Research Center Galileo Memorial Scholarship valued at $750. He plans to major in premedicine at Stanford University. The other finalists, each of whom received a $100 savings bond, were John Belliveau (left) from Woodside Priory School in Portola Valley, Randall Brynsvold (fourth from left) from Willow Glen High School in San Jose, Richard Lender (standing on first step of ladder) from Cubberley Senior High School in Palo Alto, and Patricia Lum (standing behind Brynsvold) from Henry Gunn Senior High School in Palo Alto. With them are Richard Dick (third from left) of ARO, Inc., a sponsor of the program, and Louis Haughney (right rear) of the Ames center. The awards were presented by former Ames Director, Dr. Hans Mark, at the May 5th meeting of the San Francisco Section of the American Institute of Aeronautics and Astronautics. The memorial program is in honor of the 11 men who perished in the 1973 crash of the Galileo I.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Making Life Easier for Sportsmen and Explorers

Last October 8, American climbers Chris Chandler and Bob Cormack battled freezing cold and 100-mile-an-hour winds to reach the 8,708 meter (29,028-foot) summit of Mt. Everest in the Nepalese Himalayas.

Chandler and Cormack were members of the American Bicentennial Everest Expedition, which included 12 climbers and some 500 porters. Only Chandler and Cormack made it to the top; a frozen oxygen regulator forced their Sherpa guide, Ang Phurba, to turn back in the last 300 meters.

The climbers' skill and courage were the main ingredients of the triumph, but NASA technology played an important supporting role. The transfer from space was the oxygen bottle, originally developed as rocket propellant tanks at NASA's Lewis Research Center. The bottles are produced by Luxfer USA Ltd., Riverside, Calif. and Compositek Engineering Corp., Buena Park, Calif.*

To sustain human life at elevators above 6,900 m (23,000 ft.) climbers must breathe oxygen full-time, even while sleeping. Among the 18,000 kilograms (40,000 pounds) of supplies hauled 225 kilometers (140 mi.) from Katmandu, Nepal, to Mt. Everest were 200 oxygen bottles of special design. The individual bottle is an aluminum cylinder overwrapped with reinforcing fiberglass filaments; each bottle is wrapped with 2,687 km (1,670 mi.) of filament three times finer than human hair. This type of construction reduces weight while providing a stronger cylinder. The extra strength permits higher air pressure, or more oxygen, in the same volume. Compared with steel cylinders used on previous expeditions, the Luxfer-Compositek bottles—which, incidentally, were filled at NASA's Johnson Space Center—contain approximately twice as much oxygen although they weigh almost 20 percent less.

The weight and air volume advantages of the new bottles reduced the number of cylinders needed and the overall breathing-system weight requirements by about half. This enabled the porters to carry more of the vital equipment needed at high altitude camps.

The space technology bottles were particularly important in the climb to the summit which started at an elevation of 8,235 m (27,450 ft.). At this level, climbers are able to carry only 56 kg (35 lbs.). On previous expeditions, the weight of two cylinders—an active and a spare—made up the bulk of the weight allowance. The new bottles saved Chandler and Cormack five-and-a-half pounds each. Additionally, the greater air volume of the new bottle allowed them to drop off the spare at the base of the summit for pickup on the return, thus making the load lighter for the final climb.

The light air-bottles also serve underwater, as efficient gear for SCUBA divers.

* (NASA does not endorse commercial products developed as a result of its patent licensing or technology utilization programs, but it does encourage the widest possible use of its technology.)

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